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IMT902 Microstep Driver for Two Motors

$^{1}/_{16}$th step, with constant-current drive

Source: Nanotec GmbH

The IMT902 from Nanotec is a PWM chopper type sinusoidal microstep bipolar stepper motor driver. Two stepper motors can be controlled by a single low loss and highly integrated driver IC, which is supplied in a space saving 36-pin SMD enclosure.

Besides four DMOS H bridges with an $R_{DS(on)}$ of just 0.5 Ω, the constant-current driver type IMT902 also contains two 4-bit D/A converters that enable microstep switching from 1/1 (full step) to 1/16th stepping (microstep). Sinusoidal output voltages are supplied to ensure resonance and noise free operation of the motor(s). The drivers supply the motors with voltages of up to 40 V at currents of up to 1.5 A per phase.

Further advantages of the IMT902, whose internal architecture and pinout are given in **Figure 1**, include an integrated charge pump employing two external capacitors, and the programmable 'mixed decay mode' that enables a speed-independent current drive to be realised in combination with significant reductions in power dissipation. In order to keep the number of pins on the device to a minimum, all settings are conveyed to the device via two 16-bit shift registers with latches, at a data speed of up to 25 MHz. The chopper frequency is determined by external resistors and capacitors and may extend beyond 100 kHz.

Calculations

Figure 2 shows a typical application circuit for the IMT902. Only one device half is shown (A/B). The unit C/D for the second motor is configured identically. Clearly, the stepper motor driver requires just a handful of external parts to operate. The two motor windings are connected to the respective outputs $A/\overline{A}$ and $B/\overline{B}$. The instantaneous current level through the windings is adjusted by means of the two resistors at the R_s inputs. The following equation applies:

$$I_{out} = (V_{REF}\ HC) / (5\ R_s)$$

where HC represents the hold current programmed by the respective dataword (more about this further on). The equation also allows you to calculate the power dissipation of the resistor.

Components R1 and C3 fix the oscillator frequency (and with it, the chopper rate). The oscillator frequency equals

$$f_{osc} = 1 / [C3\ (0.523\ R1 + 313.8)]\ \text{hertz}$$

and the chopper frequency is 1/8th of the oscillator frequency.

The IMT902 chip is controlled

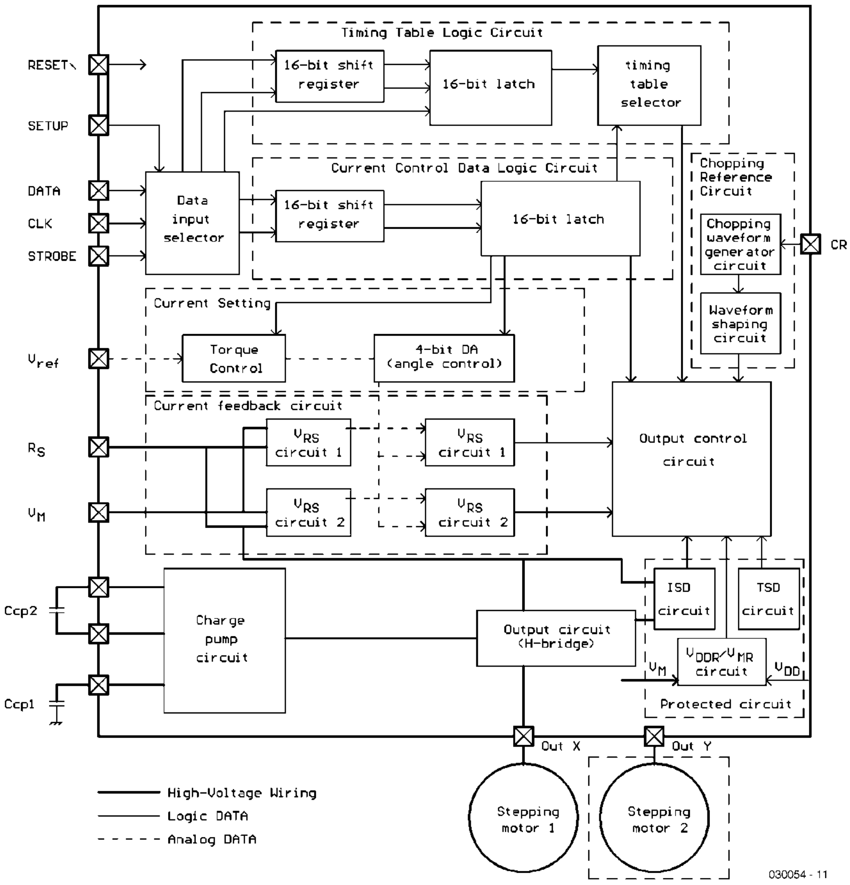

Figure 1. Internal diagram and pinout of the IMT902.

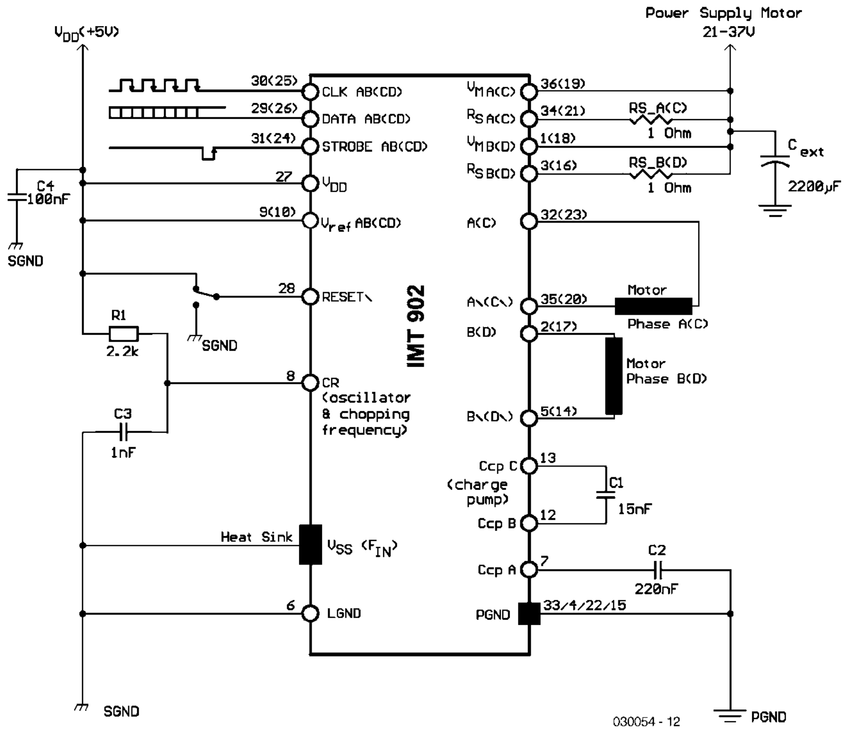

Figure 2. Standard application circuit.

1	$V_{M\,B}$	Power supply for output B block
2	OUT B	Output B pin
3	$R_{S\,B}$	Channel B current pin
4	PGND	Power GND pin
5	$\overline{\text{OUT B}}$	Output $\overline{\text{B}}$ pin
6	LGND	Logic GND pin
7	Ccp A	Capacitor pin for charge pump (Ccp1) (capacitor C2)
8	CR	External C/R (osc) pin (sets chopping frequency)
9	$V_{REF\,AB}$	V_{REF} input pin AB
F_{IN}	V_{SS}	Logic GND pin
10	$V_{REF\,CD}$	V_{REF} input pin CD
11	nc	not connected
12	Ccp B	Capacitor pin for charge pump (Ccp2) (capacitor C1)
13	Ccp A	Capacitor pin for charge pump (Ccp3) (capacitor C1)
14	$\overline{\text{OUT D}}$	Output $\overline{\text{D}}$ pin
15	PGND	Power GND pin
16	$R_{S\,D}$	Channel D current pin
17	OUT D	Output D pin
18	$V_{M\,D}$	Power supply for output D block
19	$V_{M\,C}$	Power supply for output C block
20	$\overline{\text{OUT C}}$	Output $\overline{\text{C}}$ pin
21	$R_{S\,C}$	Channel C current pin
22	PGND	Power GND pin
23	OUT C	Output C pin
24	STROBE CD	CD Strobe (latch) Signal input pin
25	CLK CD	CD clock input pin
26	DATA CD	CD serial data signal input pin
27	V_{DD}	Power pin for logic block
F_{IN}	V_{SS}	Logic GND pin
28	$\overline{\text{RESET}}$	Output reset signal input pin
29	DATA AB	AB serial data signal input pin
30	CLK AB	AB clock input pin
31	STROBE AB	AB Strobe (latch) Signal input pin
32	OUT A	Output A pin
33	PGND	Power GND pin
34	$R_{S\,A}$	Channel A current pin
35	$\overline{\text{OUT A}}$	Output $\overline{\text{A}}$ pin
36	$V_{M\,A}$	Channel A current pin
All GND pins and F_{IN} must be grounded.		

using its DATA, CLK and STROBE inputs. Besides, there's a reset switch which not only clears the outputs but also all registers/latches.

Control

To control the IMT902 three signals are needed: clock serial data and a strobe pulse (see **Figure 3**). The dataword has a total width of 16 bits. Each bit in the sequence DATA0 (LSB) through DATA15 (MSB) is applied at the rising edge of the clock signal, and shifted into the shift register on the falling edge. Once all 16 bits have been copied in, the rising edge of the strobe pulse causes the data to be copied into the internal latch. During the data reception phase, the strobe signal may be Low or High.

The first two bits program the hold current, the next two, the decay mode. Next arrive the 4 bits that set the current in motor phase B using the internal D/A converter, followed by a bit for the phase information — in other words, the current direction. Bits 9 through 15 repeat this information for phase A (**Table 1**). Obviously, the other motor is controlled with its very own dataword.

The device datasheet at

http://nanotec.com/page_steuerungen_imt902_en.html

provides tables for each mode of operation (from full step to 1/16th step) that list all relevant datawords. **Figure 4** shows an extract from such a table, as well as the associated current curve. With full-step mode a pure rectangular signal is used (the internal DACs always supply both currents at 100% intensity), while only the current direction is reversed. By contrast, Figure 4 illustrates the almost sinusoidal current that flows in 1/16th step (microstep) mode.

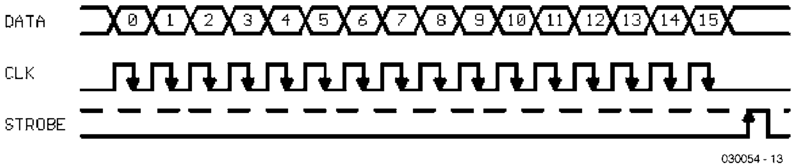

Figure 3. Serial input data.

Table 1. Dataword structure

DATA	Name	Function
0 (LSB)	Hold Current 0	HH = 100 %, LH = 85 %, HL = 70 %, LL = 50 %
1	Hold Current 1	
2	Decay Mode B_0	HH = fast decay, LH = mixed decay 37.5 %, HL = mixed decay 75 %, LL = slow decay
3	Decay Mode B_1	
4	Current B_0	Current for phase B (LLLL = all outputs off) max. 16 steps possible
5	Current B_1	
6	Current B_2	
7	Current B_3	
8	Phase B	H: OUT B = High, $\overline{\text{OUT B}}$ = Low, L = OUT B = Low, $\overline{\text{OUT B}}$ = High
9	Decay Mode A_0	HH = fast decay, LH = mixed decay 37.5 %, HL = mixed decay 75 %, LL = slow decay
10	Decay Mode A_1	
11	Current A_0	Current for phase A (LLLL = all outputs off) max. 16 steps possible
12	Current A_1	
13	Current A_2	
14	Current A_3	
15 (MSB)	Phase A	H: OUT A = High, $\overline{\text{OUT A}}$ = Low, L = OUT A = Low, $\overline{\text{OUT A}}$ = High

Details

The internal functions referred to as TSD and ISD provide an effective protection against overheating (thermal shutdown) and current overload (overcurrent protection) respectively. The TSD guard is activated at a device temperature of 130 degrees Celcius typ. (up to 170 degrees C) and shuts down the outputs to both motors. At the same time, the charge pumps are cut off and the registers cleared. The IMT902 may be released from this state by means of a reset pulse, but only if the device temperature has dropped below 35 degrees Celcius.

A similar scheme applies to the overcurrent protection circuit. As soon as the ISD guard registers excessive output current, both motor windings and the charge pumps are switched off. Also, all functional data is cleared. The overcurrent protection remains active until a reset action. Despite these protective measures a fuse should be included in the power supply line.

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	Hold Current 0	Hold Current 1	Decay B_0	Decay B_1	B_0	B_1	B_2	B_3	Phase B	Decay A_0	Decay A_1	A_0	A_1	A_2	A_3	Phase A
Bit	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	1	1	1	0	1	1	1	1	1	1	0	0	0	0	0	1
2	1	1	1	0	1	1	1	1	1	1	0	1	0	0	0	1
3	1	1	1	0	0	1	1	1	1	1	0	0	1	0	0	1
4	1	1	1	0	1	0	1	1	1	1	0	1	1	0	0	1
5	1	1	1	0	0	0	1	1	1	1	0	0	0	1	0	1
6	1	1	1	0	1	1	0	1	1	1	0	1	0	1	0	1
7	1	1	1	0	0	1	0	1	1	1	0	0	1	1	0	1
8	1	1	1	0	1	0	0	1	1	1	0	1	1	1	0	1
9	1	1	1	0	0	0	0	1	1	1	0	0	0	0	1	1
10	1	1	1	0	1	1	1	0	1	1	0	1	0	0	1	1
11	1	1	1	0	0	1	1	0	1	1	0	0	1	0	1	1
12	1	1	1	0	1	0	1	0	1	1	0	1	1	0	1	1
13	1	1	1	0	0	0	1	0	1	1	0	0	0	1	1	1
14	1	1	1	0	1	1	0	0	1	1	0	1	0	1	1	1
15	1	1	1	0	0	1	0	0	1	1	0	0	1	1	1	1
16	1	1	1	0	1	0	0	0	1	1	0	1	1	1	1	1

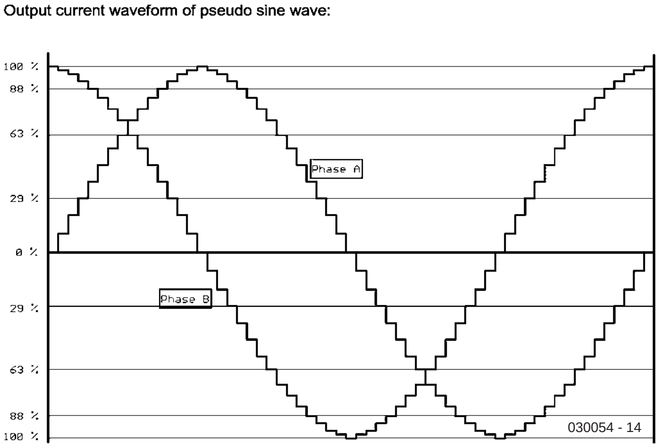

Figure 4. Sample of current shape for 1/16th step mode with associated control words.